What is claimed is:



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1. A method of forming a Cu alloy, comprising:

plating a layer of **Q**u over a substrate;

forming a dopant laver over the Cu layer;

driving dopants from the dopant layer into the Cu layer; and

removing the dopant layer.

- 1 2. The method of Claim 1, wherein the substrate comprises a diffusion
- 2 barrier layer overlying a dielectric layer.
- 1 3. The method of Claim 2, wherein the diffusion barrier layer comprises a
- 2 material selected from the group consisting of Ta, TaN, TaSiN, W, WN, WSiN,
- 3 Ti, TiN, TiSiN, and Co.
- 1 4. The method of Claim 2, wherein forming the dopant layer comprises
- 2 plating a layer of metal.
- 1 5. The method of Claim 4, wherein the metal layer comprises at least one
- 2 element which when alloyed with Cu improves an electromigration characteristic
- 3 of Cu.

- 1 6. The method of Claim 5, wherein the at least one element is selected from
- 2 the group consisting of Sn, Al, Mg and Co.
- 1 7. The method of Claim 5, wherein plating the layer of Cu comprises
- 2 electroplating.
- 1 8. The method of Claim 5, wherein plating the layer of Cu comprises an
- 2 electroless deposition.
- 1 9. The method of Claim 6, wherein driving dopants into the Cu layer
- 2 comprises elevating the temperature of the dopant layer and Cu layers to
- 3 between 300°C and 400°C.
 - 10. A method of forming a Ct alloy, comprising:

 plating a layer of Cu over a substrate; and

 implanting at least one dopant element into the Cu layer.
- 1 11. The method of Claim 10, wherein the at least one dopant element is
- 2 selected from the group consisting ALMg, and Sn.
- 1 12. The method of Claim 10, further comprising polishing the layer of Cu so
- 2 as to form individual interconnect lines prior to implanting.

- 1 13. The method of Claim 12, further comprising depositing a barrier layer over
- 2 the interconnect lines subsequent to implanting.
- 1 14. The method of Claim 13, wherein the barrier layer is formed of a material
- 2 selected from the group consisting of SiC and SiN.
- 1 15. The method of Claim 12, further comprising depositing a barrier layer over
- the interconnect lines prior to implanting. 2
- 1 16. The method of Claim 12, wherein the dopant is implanted into the surface
- 2 of the Cu to depth of about 10 monolayers.
- 1 17. The method of Claim 12, wherein the dopant is implanted a dose of 3E15
- atoms/cm² at an energy of 5keV. 2
- 18. 1 The method of Claim 12, wherein the dopant is implanted to achieve an
- implant profile peak at 50 angstroms below the Cu surface and a concentration 2
- 3 of 1.5 wt% over 100 angstroms.
 - A method of forming a Cu alloy, comprising: 19.

depositing a seed layer on a substrate, the seed layer comprising Cu and

at least one doping elément;

- 4 forming a capping over the seed layer;
- forming a layer of Cu over the capping layer; and
- driving the at least one doping element from the seed layer into the Cu
- 7 layer.
- 1 20. The method of Claim 19, wherein the seed layer and the capping layer are
- 2 formed sequentially and without exposing the seed layer to the atmosphere prior
- 3 to deposition of the capping layer.
- 1 21. The method of Claim 20, wherein the seed layer and the capping layer are
- 2 deposited in the same PVD system without breaking vacuum.
- 1 22. The method of Claim 19, wherein depositing the seed layer comprises
- 2 sputtering a metal alloy, the metal alloy having at least one element that diffuses
- 3 in Cu at a temperature less than or equal to 400°C.
- 1 23. The method of Claim 22, wherein the metal alloy is selected from the
- 2 group consisting of CuSn and CuMg.
- 1 24. The method of Claim 22, wherein forming the capping layer comprises
- 2 sputtering Cu.



- 1 25. The method of Claim 19, wherein driving the at least one doping element
- 2 from the seed layer into the Cu layer comprises heating the substrate to
- 3 temperature in the range of 300°C to 400°C.
- 1 26. The method of Claim 25, further comprising exposing at least the surface
- 2 of the Cu layer to an ambient that reacts with the doping element.
- 1 27. The method of Claim 26, wherein the ambient comprises nitrogen.
- 1 28. The method of Claim 26, wherein the ambient comprises oxygen.
- 1 29. The method of Claim 19, wherein the substrate comprises a patterned
- 2 dielectric layer having a copper diffusion barrier disposed of the surfaces thereof;
- 3 depositing the seed layer comprises a physical vapor deposition in the absence
- 4 of oxygen; forming the capping layer comprises a physical vapor deposition of
- 5 Cu; forming the Cu layer comprises electroplating; and driving the at least one
- 6 doping element from the seed layer into the Cu layer comprises heating the
- 7 substrate and, concurrently therewith, exposing the Cu layer to at least one
- 8 chemical that will react with the at least one doping element such that the at
- 9 least one doping element is drawn to the surface of the Cu layer.